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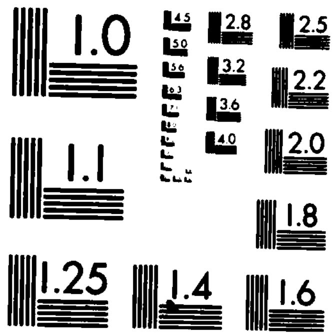
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MEMORANDUM REPORT ARCCB-MR-86023

AD-A171 096

EVALUATION OF CORROSION RESISTANT SURFACES ON 6061 ALUMINUM ALLOY

EDWARD TROIANO

JULY 1986

US ARMY ARMAMENT RESEARCH AND DEVELOPMENT CENTER
CLOSE COMBAT ARMAMENTS CENTER
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20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

This study was undertaken in order to provide corrosion protection for 6061 aluminum. Anodizing (Type II and III), chemical conversion coating, and solid film lubricants were tested and evaluated. It was found that anodizing Type II offers excellent corrosion protection, but in cases where anodizing cannot be used, chemical conversion coating and solid film lubricants offer ample corrosion protection.

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BACKGROUND AND INTRODUCTION

The purpose of this investigation was to test and evaluate various corrosion resistant surfaces on 6061 aluminum. The study was initiated by a request to have Type III anodizing applied (MIL-A-8625C) on the mating surface between an aluminum bore evacuator and a gun tube. The problem encountered was, according to specification MIL-A-8625C 3.3.7, "ANODIC COATINGS SHALL NOT BE APPLIED TO ASSEMBLIES WHICH WILL ENTRAP THE ELECTROLYTE IN JOINTS OR RECESSES." By viewing Figure 1, one can see the proposed corrosion resistant area and the joint in question.

This study includes corrosion tests on anodized surfaces (Type II and Type III, MIL-A8625C) and also chemical conversion coated surfaces (MIL-C-5541C). All surfaces were also tested using heat cured and air cured solid film lubricants (MIL-L-8937 and MIL-L-46147A). Solid film lubricants (SFL) were tested for two reasons; first, they add additional resistance to corrosion, and second, they act as a lubricant which is beneficial when trying to remove the bore evacuator from the gun tube.

According to MIL-A-8625C, if there is any possibility of the electrolyte (anodizing) entering a joint or recess, that joint or recess should be masked off to prevent the electrolyte from entering it. That led to the possibility of creating a mask to seal off the joint in question (See Figure 1). The proposal to make a mask was not pursued, however, due to the difficulty of producing a mask and also the tedious and laborious job of applying the mask to every bore evacuator. Finally, an alternate solution to anodizing had to be investigated. This investigation led to the testing and evaluation of chemical conversion coating and solid film lubricants. The procedure used, results and evaluation of testing and recommendations follow.

APPROACH TO THE PROBLEM

Initially, there were 18 pieces of 3" x 10" 6061 aluminum plates labeled 1-9 and 1A-9A. After the initial testing of these 18 specimens, 6 more were added labeled 10-15. Each of the 24 test samples was subjected to the following coatings:

TABLE I - COATINGS

		Exterior Coating		
		Heat Cured SFL	Air Cured SFL	None
Interior Coating	Chemical Conversion Coat	1, 1A, 10, 11	2, 2A, 12, 13	3, 3A, 14, 15
	Anodized Type II Class I	4, 4A	5, 5A	6, 6A
	Anodized Type III	7, 7A	8, 8A	9, 9A

After each piece had been properly coated (according to their respective specification), they were subjected to several tests. The first test done was the adhesion test (ASTM D2510). This test states that tape shall be applied to the coated metal and then lifted off. This action should not expose any surface of the underlying metal. If any bare metal is exposed, the test specimen should be rejected. The second test used was to subject the test specimens to a corrosive salt spray environment (ASTM-B117-73). This test was performed in two different ways. Specimens 1A-9A and 10-15 were subjected to the salt spray chamber as coated in Table I; while specimens 1-9 were subjected to a scribed line which protruded through the coatings and into the base metal so as to expose the base metal to the corrosive environment.

After all 24 specimens had been removed from the salt chamber, a recommendation was made to compare the corrosion protection surface that is currently being used on steel bore evacuators to the corrosion protection that the chemical conversion coat

and solid film lubricants provide. This led to welding a piece of carbon steel with phosphating and heat cured solid film lubricant applied and cured at 400°F. The aluminum was also welded and had chemical conversion coating and heat cured solid film lubricant applied and cured at 300°F. Both welded specimens were then placed in the salt spray cabinet.

RESULTS & DISCUSSION OF RESULTS

After each specimen had been properly coated according to Table I, each sample was tested for adhesion. It was observed in all cases that the adhesion of the coating to the base metal was strong enough to prevent any of the coating from being removed. The results of this particular test show proper and acceptable adhesion of all coatings on their underlying aluminum bases. Next, the scratched and unscratched specimens were placed in a salt spray atmosphere, the scratched specimens were subjected to 120 hours of corrosive environment and the unscratched specimens were subject to 288 hours of corrosive environment. (Photographs of each specimen follow). After the specimens were removed from the salt spray chamber, they were cleaned, dried and evaluated on a scale from 1 to 3; 1 being the most corrosion resistant, 3 being the least corrosion resistant. When more than one sample of the same specimen was tested, an average was taken of those specimens and the results are listed below.

TABLE II

Scratched Specimens (120 hours of corrosive environment)
Samples 1-9

		Exterior Coating		
		Heat Cured SFL	Air Cured SFL	None
Interior Coating	Chemical Conversion Coat	1	2	1
	Anodized Type II Class I	2	2	1
	Anodized Type III	2	2	3

TABLE III

Unscratched Specimens (288 hours of corrosive environment)
Samples 1A-9A, 10-15

Interior Coating		Exterior Coating: Heat Cured SFL	Exterior Coating: Air Cured SFL	Exterior Coating: None
	Chemical Conversion Coat	2	3	3
	Anodized Type II Class I	1	1	1
	Anodized Type III	1	1	3

Both welded specimens were removed after a total of 216 hours of corrosive environment. They, too, were rated on a scale from 1 to 3 with the following results:

TABLE IV

Welded Specimens (216 hours of corrosive environment)

Interior Coating		Exterior Coating: Heat Cured SFL
	Carbon Steel - Phosphate	3
	6061 Aluminum - Chemical Conversion Coat	1

CONCLUSION:

From the results presented in Tables II and III, it can be seen in most cases that the anodized surfaces provided better corrosion protection than the chemical conversion coated surfaces. But due to the nature of the problem (the fact that anodizing will corrode the weld and surrounding area), an anodized surface cannot be used.

It is the findings of this study that in the event it becomes too difficult to mask off a questionable area that is to be anodized, a chemical conversion coating and heat cured solid film lubricant will provide a reasonable amount of corrosion protection. If this corrosion protection is deemed to be inadequate, a mask must be developed, and then we will recommend an anodized Type II Class I surface and possibly a solid film lubricant exterior surface.

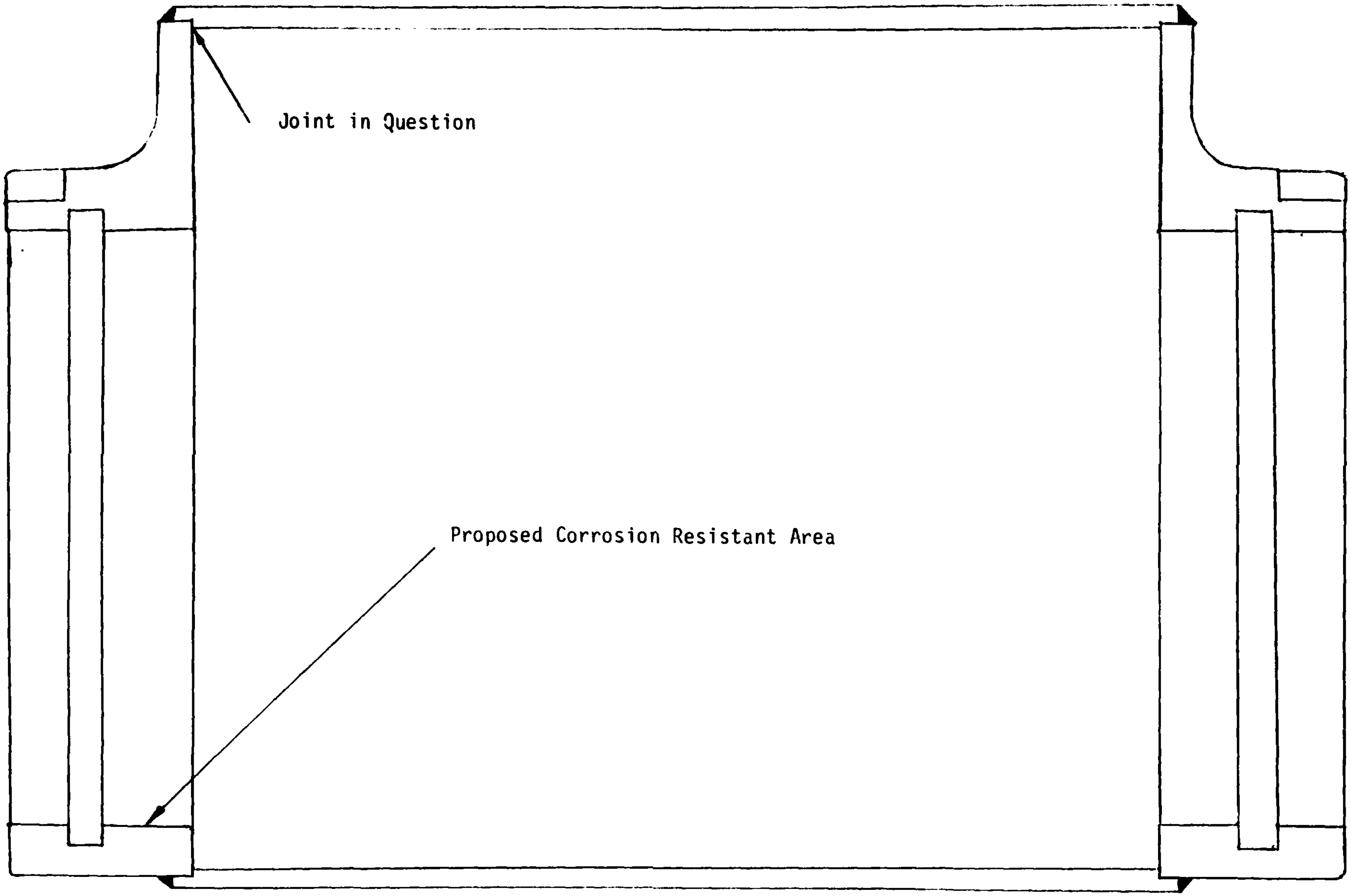
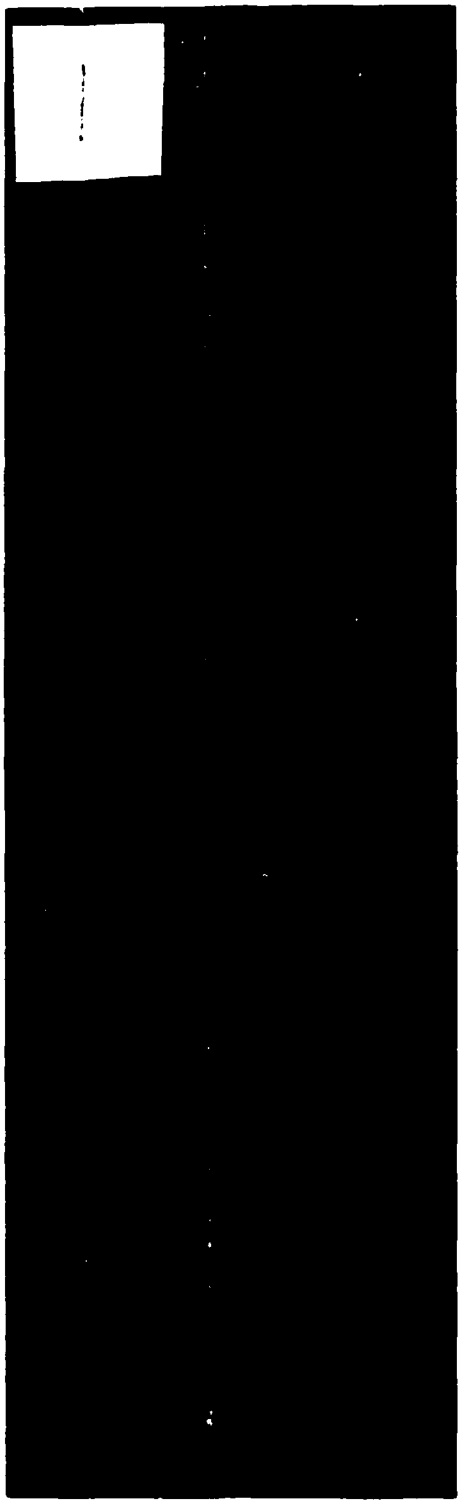


FIGURE 1 - CUT AWAY VIEW - 105mm XM24 BORE EVACUATOR



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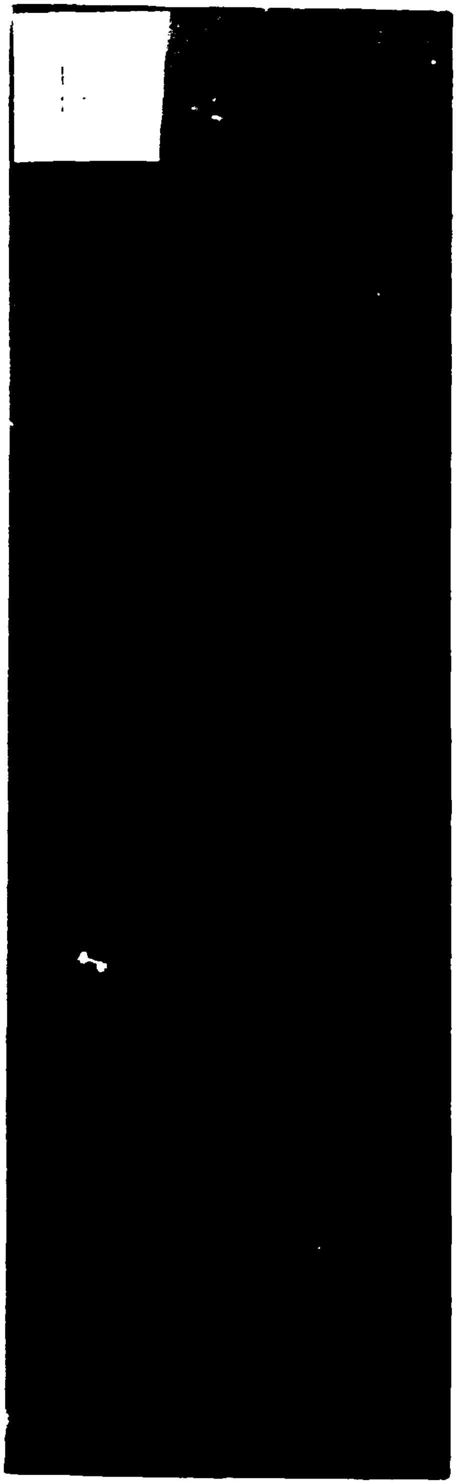

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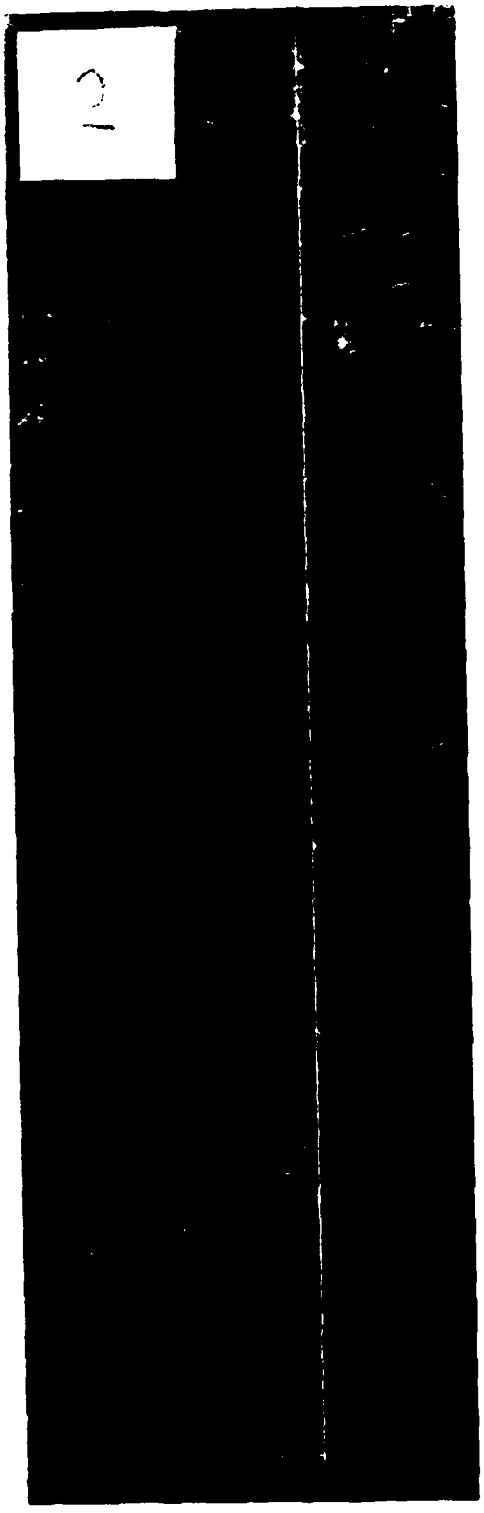

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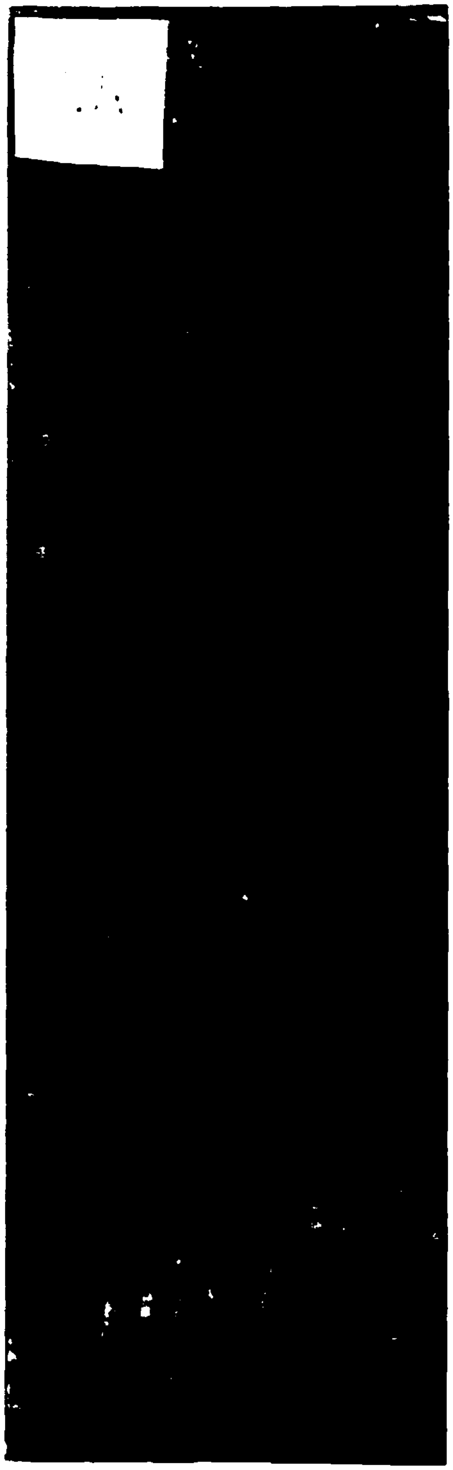

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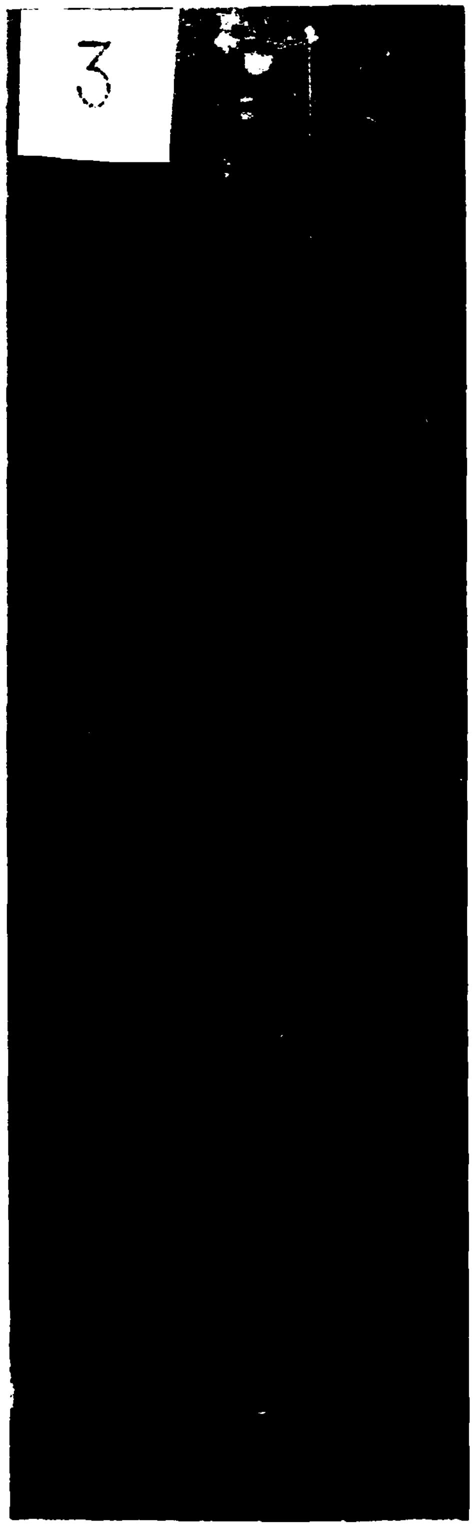

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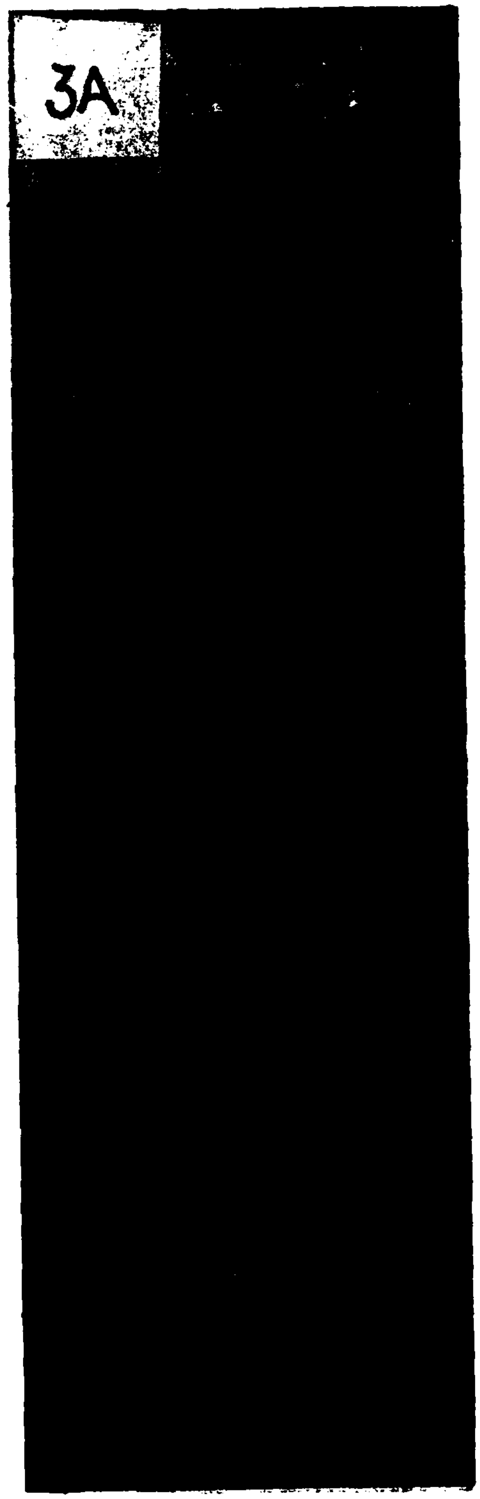

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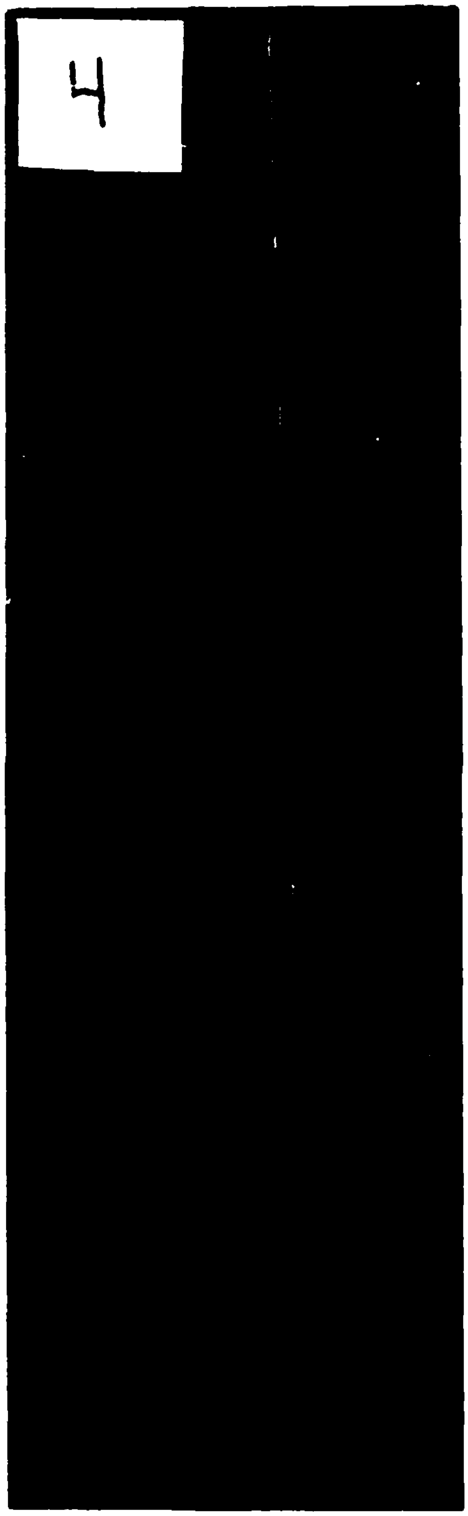

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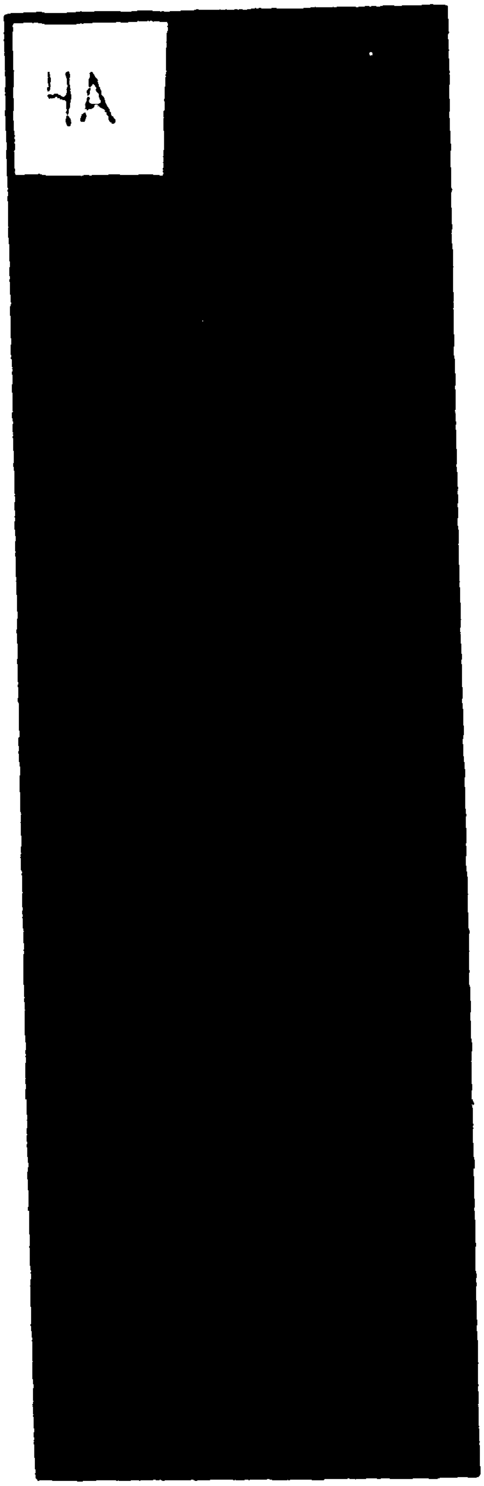

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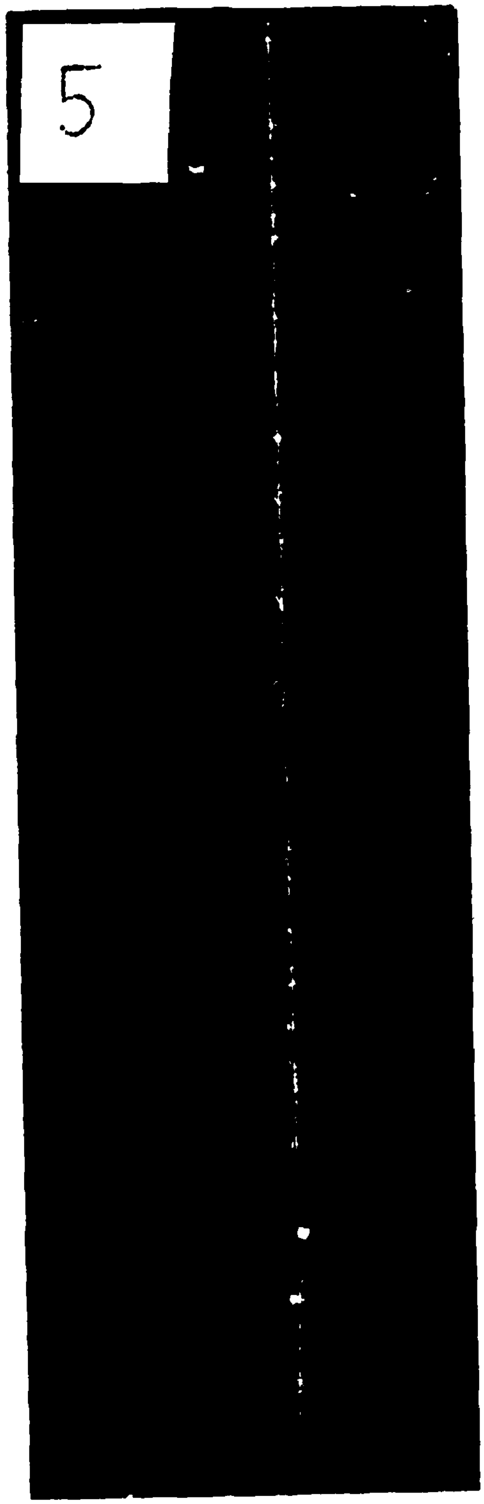

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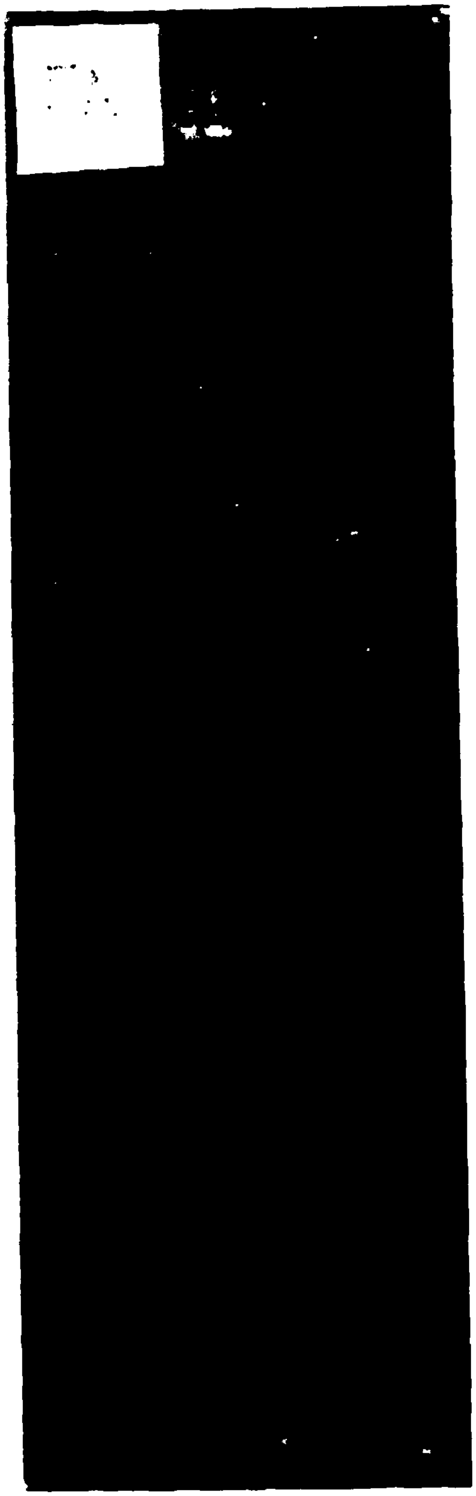

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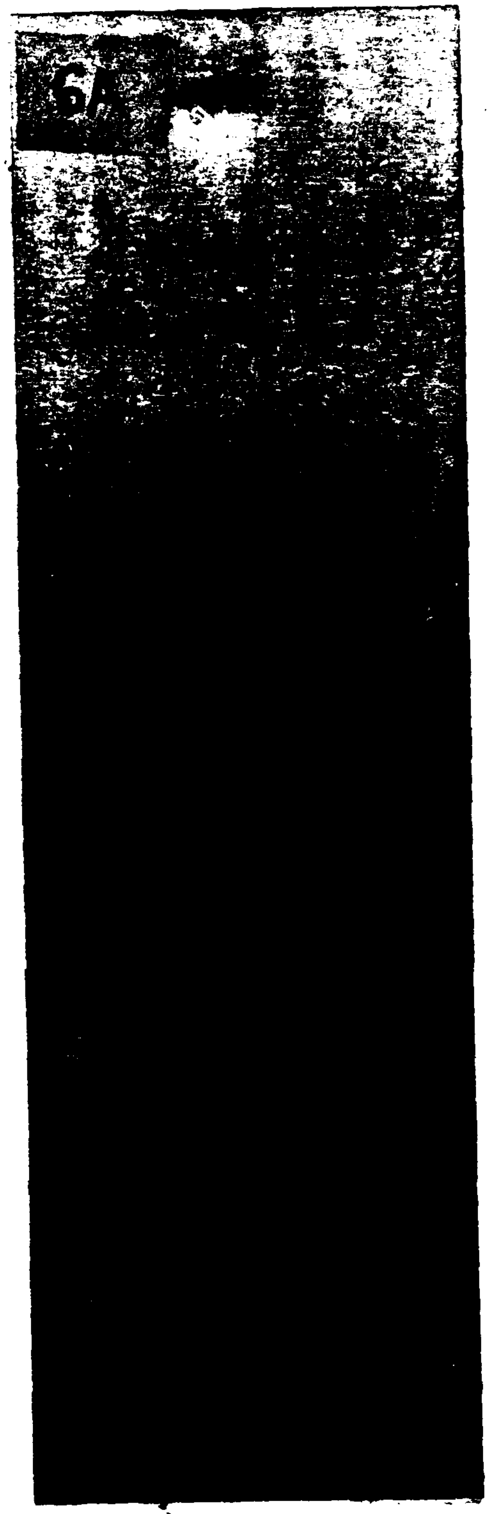

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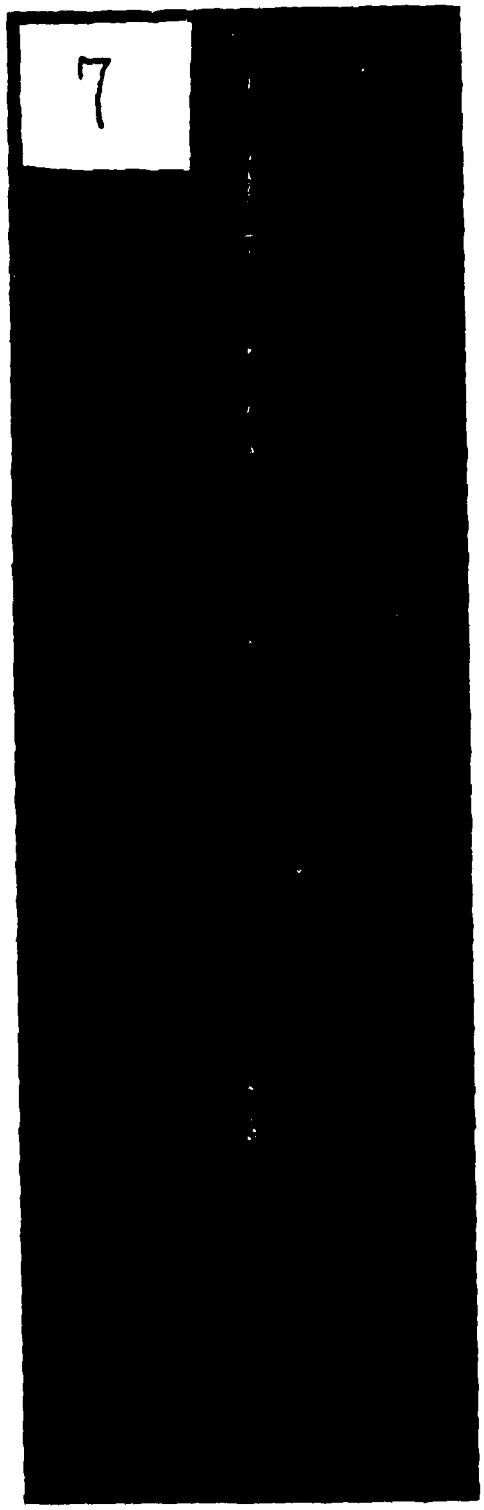

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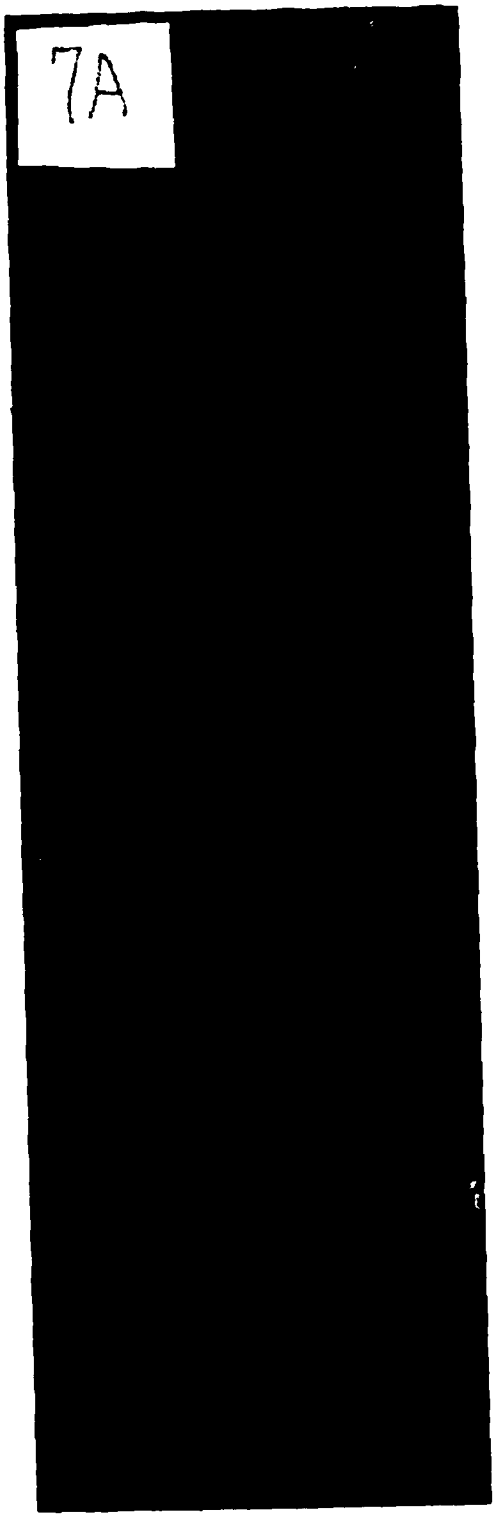

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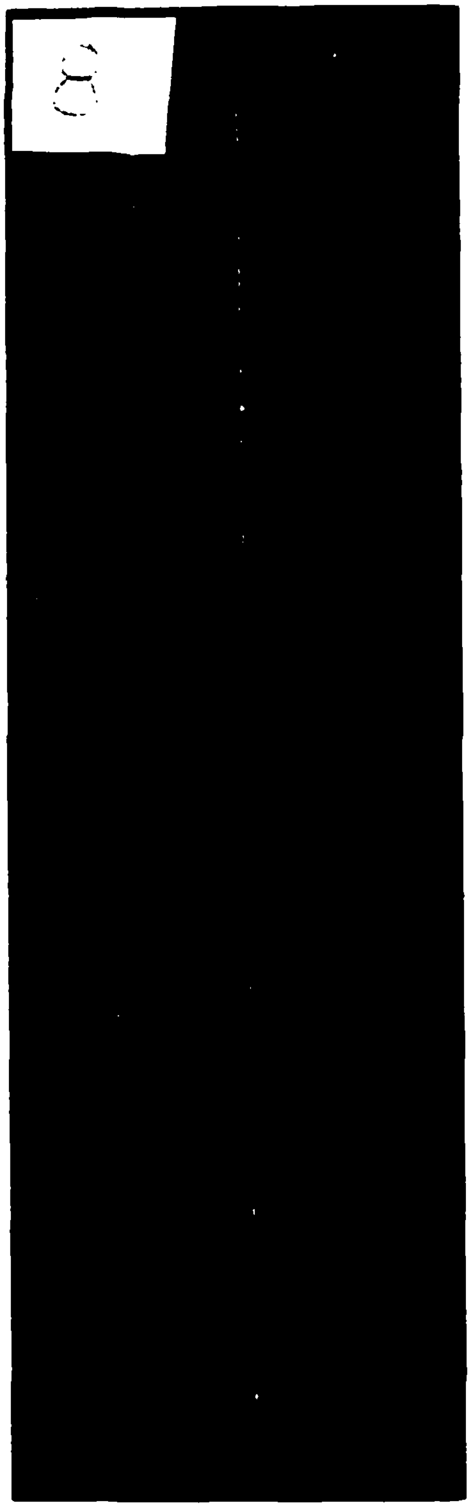

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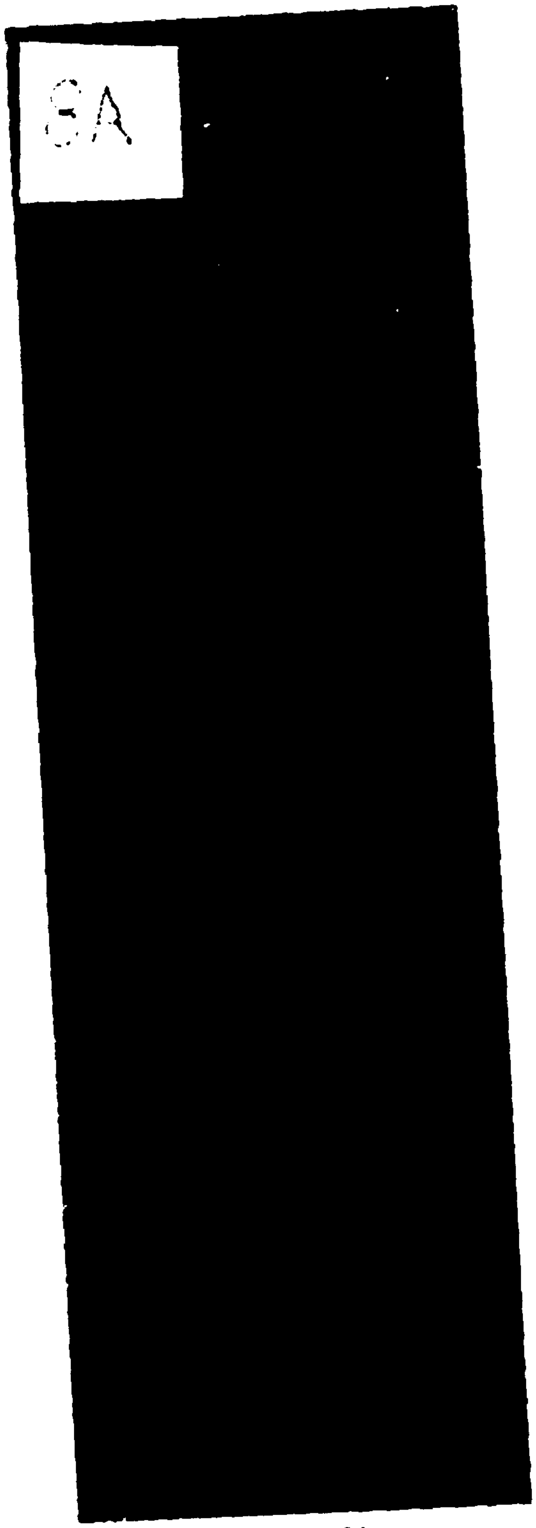

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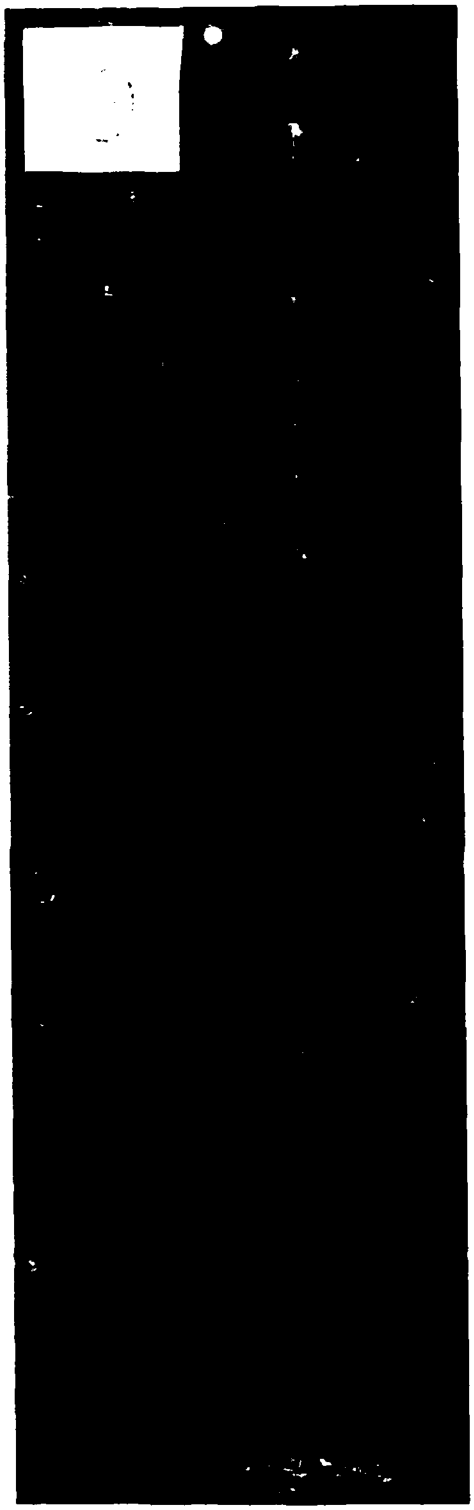

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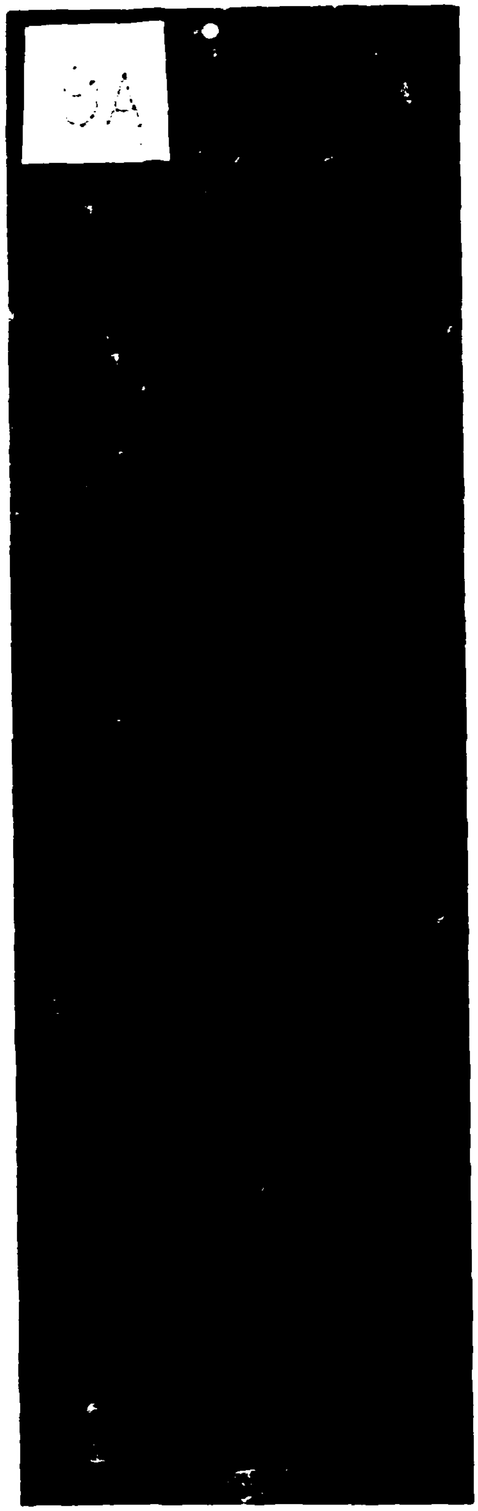

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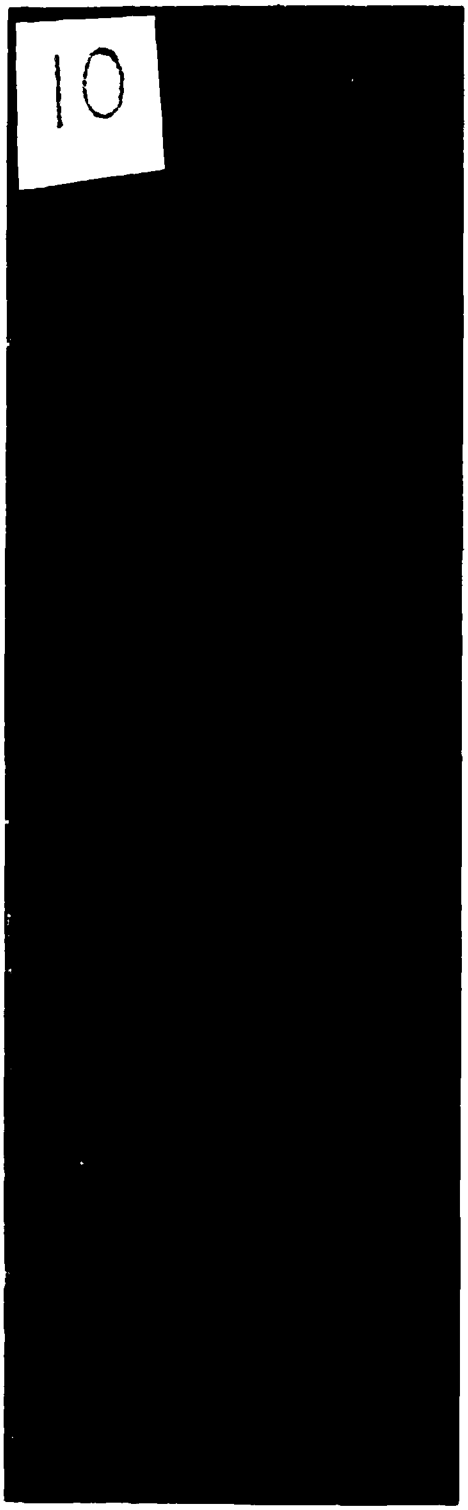

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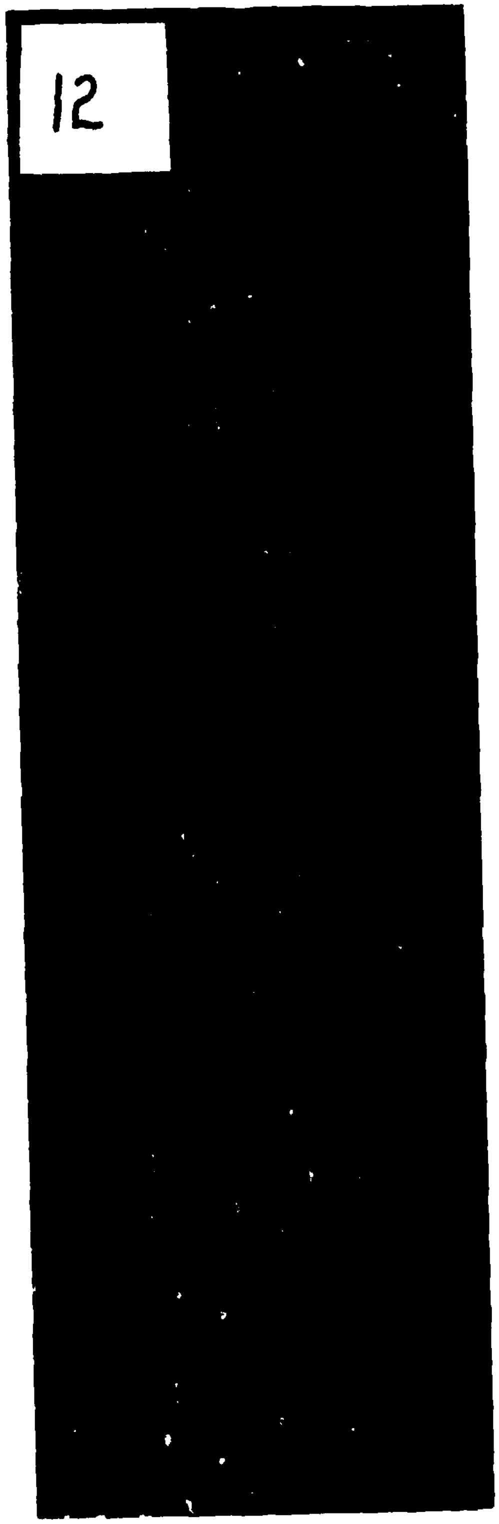

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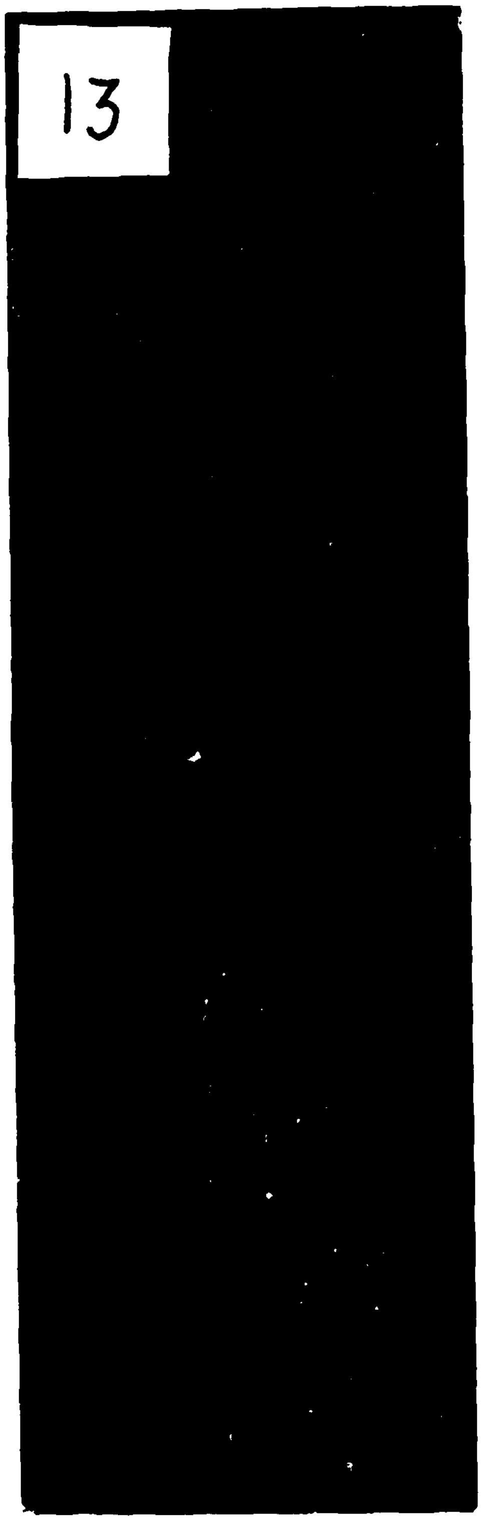

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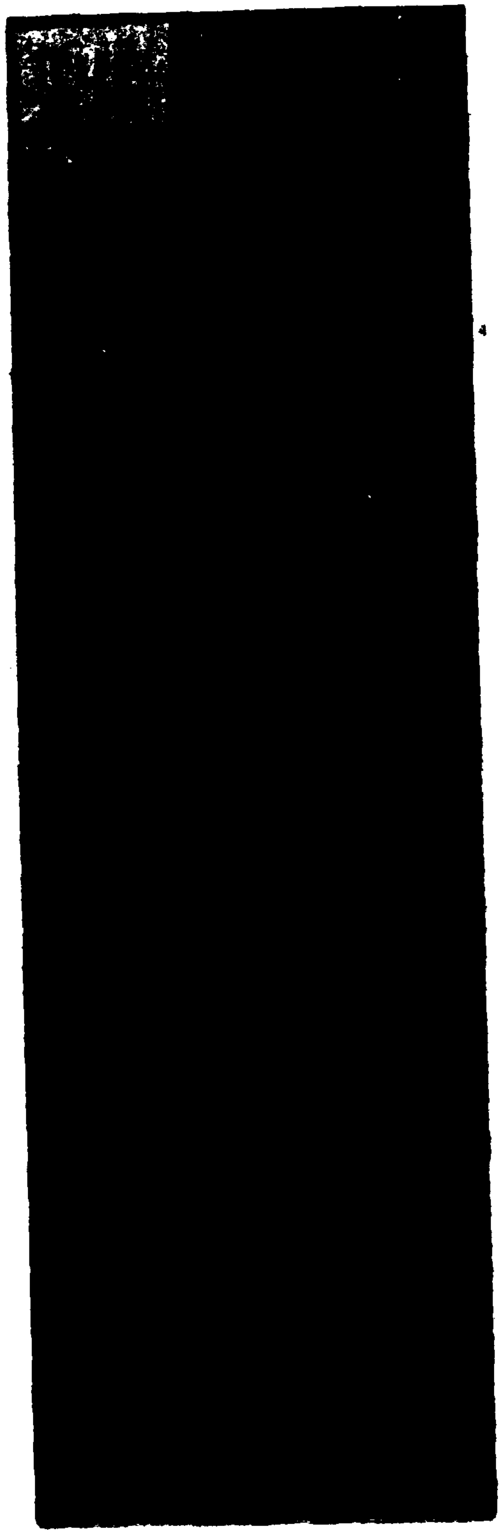

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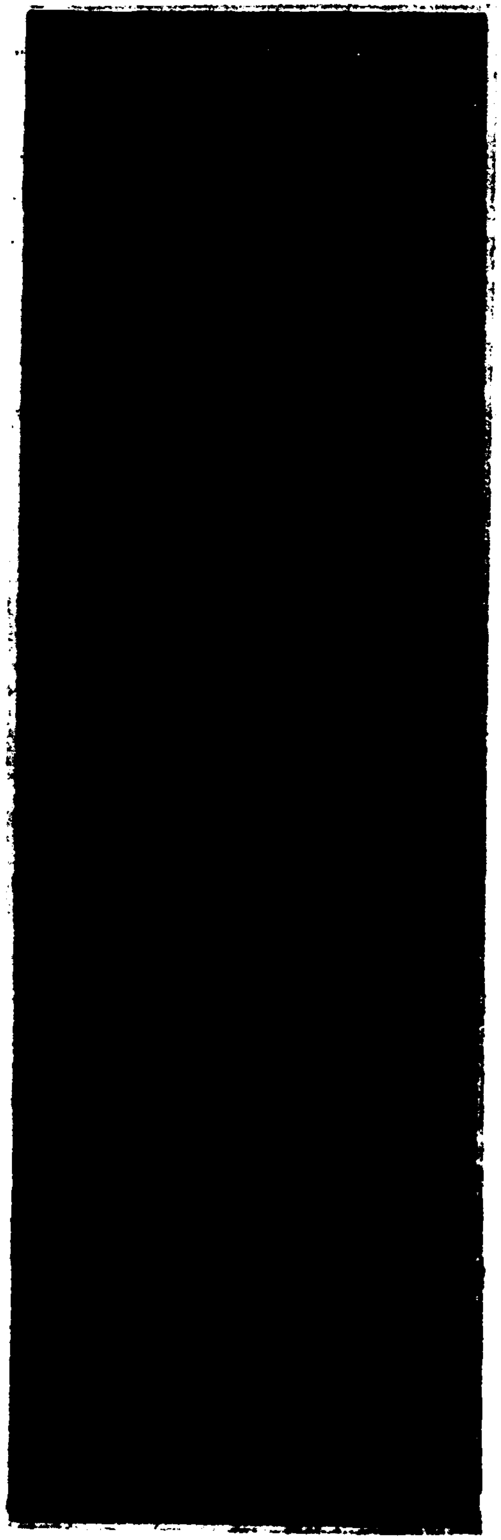

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